

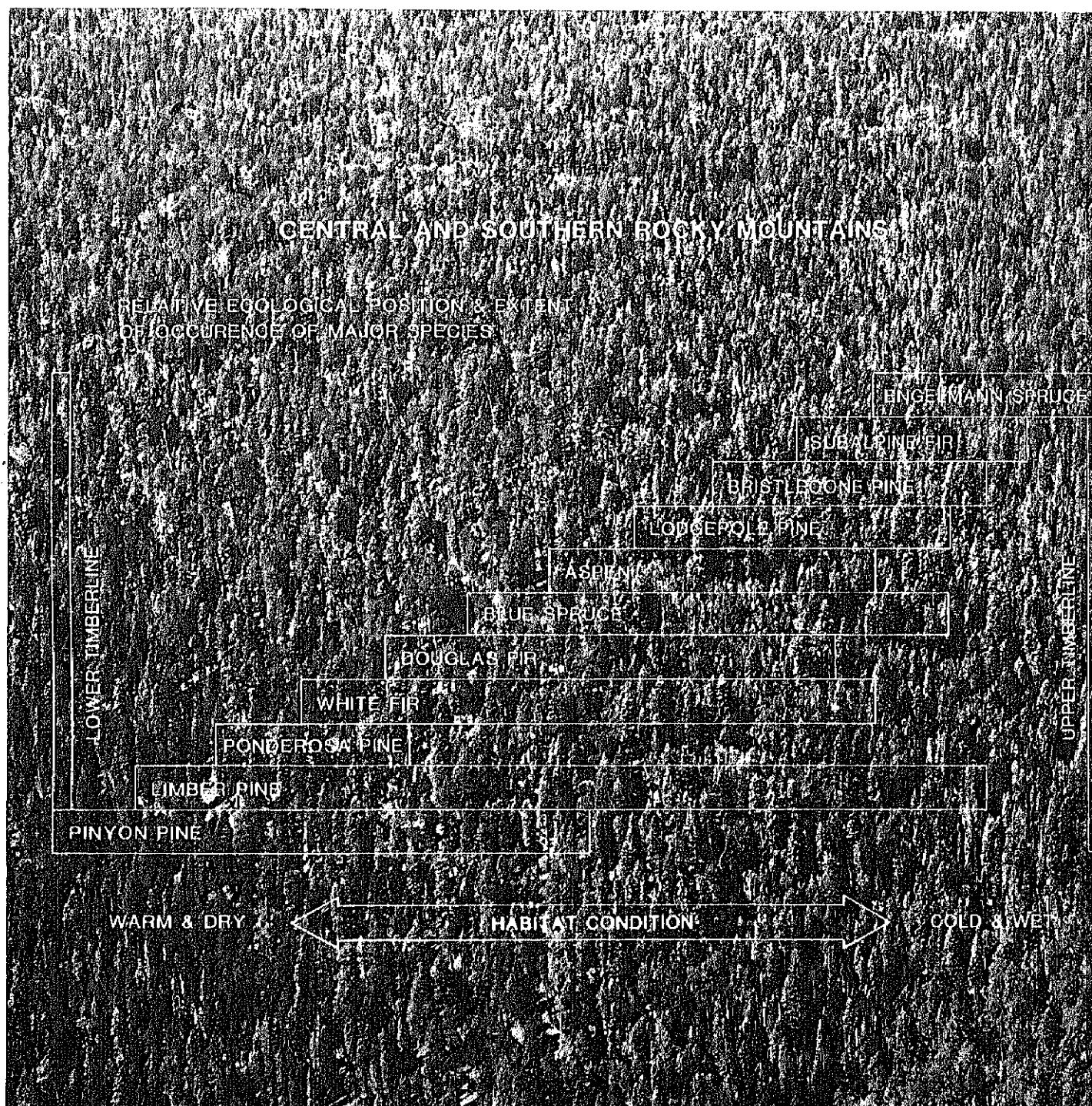


United States
Department of
Agriculture

Forest Service

June 1983

Forestry Research West



A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture

Forestry Research West

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Cover

Scientists at the Rocky Mountain Station have developed a series of slide-tape programs to help resource specialists understand and apply the most appropriate silvicultural systems for the major Central Rockies timber types. Read about it on page 9.

To Order Publications

Single copies of publications referred to in this magazine are available without charge from the issuing station unless another source is indicated. See page 19 for ordering cards.

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To change address, notify the magazine as early as possible. Send mailing label from this magazine and new address. Don't forget to include your Zip Code.

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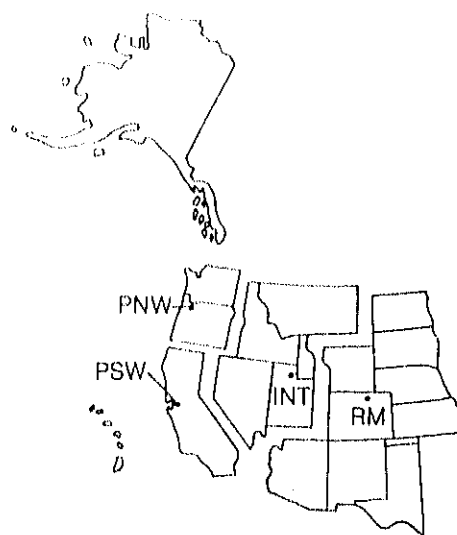
Western Forest Experiment Stations

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Ogden, Utah 84401

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240 West Prospect Street
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Managing the soil for forest trees

by Delpha Noble
Intermountain Station

An acre of forest land harbors a vast living community. It's easy to see the trees, shrubs, and herbs that cover the ground. But also on the surface and below are teeming billions of bacteria, fungi, soil mites, earthworms, and other organisms. Without these inconspicuous residents, the surface vegetation would not exist. And this microcommunity needs food.

In most forests, litter, and humus accumulate on the ground from decaying leaves, branches, tree trunks, and sometimes harvesting debris. The decaying plant materials tie up, then gradually release, substantial quantities of nutrients. They also help retain moisture, provide shade, and can restrict air and large animal movement.

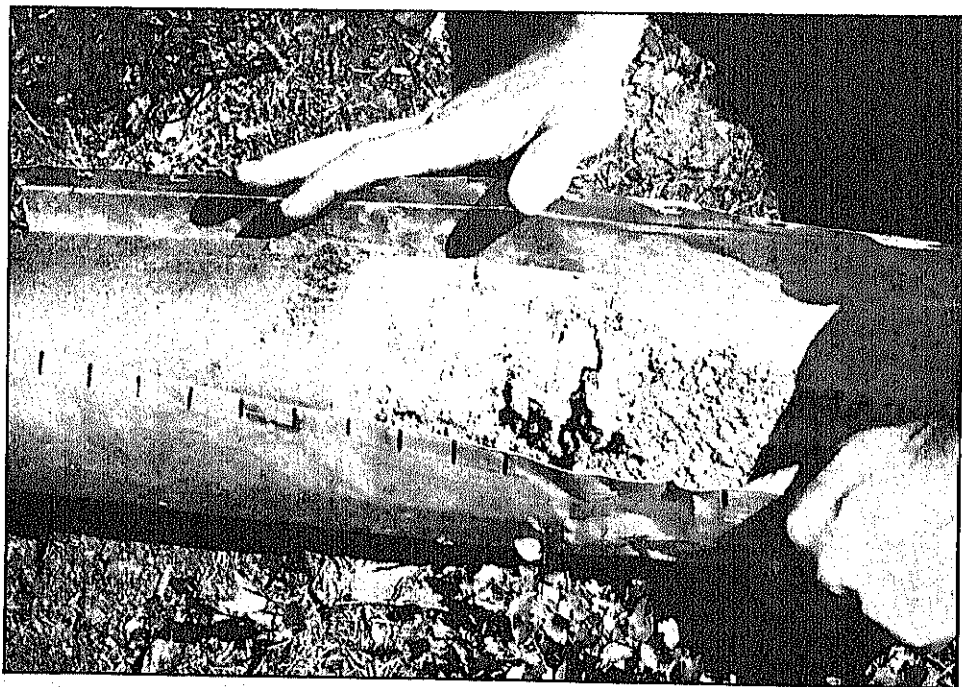
These decaying organic materials provide the environment and often the energy source, or food, for

microorganisms critical to the survival and growth of conifers of the central and northern Rocky Mountains. Perhaps the most important microorganisms in the natural recycling of wood are fungi. Fungi are key biological mediators of post-harvest nutritional balances within the forest soil.

Nutritional balances within the forest soil are of primary interest to land managers responsible for regeneration activities. The National Forest Management Act of 1976 requires that current reforestation backlogs be essentially eliminated by October 1, 1984, and that reforestation there after be maintained at the same rate as timber is harvested.

This mandate has focused attention on the ability of forest soils to produce and support healthy, natural tree seedlings as well as on the condition of tree seedlings that are planted on harvested sites. Success or failure of natural regeneration or a tree planting operation can depend on whether the forest soils provide critical biological, physical, and chemical characteristics that support the young conifers. A land manager responsible for reforestation activities should consider several questions in the decision-making process: Will the soil produce healthy trees? Is the nursery stock in the best possible condition for transplanting? How much debris should be left on a harvested site? What about the effects on the soil of prescribed burning or wildfires? In some areas, a land manager's most important harvesting decision in the long run might be the scheduling of sites to prevent soil damage.

Researchers take a core sample to measure the physical makeup and microbiological activities of forest soil.



Throughout a longstanding cooperative effort, researchers at the Intermountain Station, the Forest Products Laboratory, and Michigan Technological University have focused on the biology of forest soils and its implications for forest productivity. Alan E. Harvey, project leader, Intermountain Station; Martin F. Jurgensen, professor of forest soils, Michigan Technological University; and Michael J. Larsen, research mycologist, Forest Products Laboratory, have singly and jointly produced a wealth of information on this subject. They have documented their findings in many publications, some on such highly specific subjects as residue decay processes, ectomycorrhizae (symbiotic fungus-root combinations), and nitrogen fixation (the biological conversion or "fixation" of atmospheric nitrogen into organic complexes). This and other information provide guidelines for land managers involved with planting trees in the field or working with seedlings in the nursery.

Ronald Hamilton, in charge of timber stand improvement and nursery operations for the Intermountain Region, says, "We are faced with a backlog of areas needing reforestation that are 'super-clean,' and have had trouble getting regeneration started in those places. In the Intermountain Region, some areas are swept with high winds, scraping everything away. We're changing from an era of complete cleanup. Harvey's studies have added a much more scientific basis for our decisions. We as land managers are having to explain why we are leaving the stuff out there, and the scientific data supports us."

Peter Laird, reforestation manager for the Northern Region, echoes Hamilton's concerns. He says, "We left too much debris in the 1950's and 1960's, too little in the 1970's. We need scientifically-based guidelines, and we are now using Harvey and the other's work. We're trying to leave additional material out there to protect the seedlings and leave debris that will provide the essential nutrients."

The question of residual debris in site preparation is a dominant one. Harvey says it's obvious that too much mechanical site preparation destroys microsite conditions suitable for seedling establishment. Equally obvious, however, is that very little, or almost no, mechanical disturbance produces an undesirable result—poor seed germination. So the question is—how much and under what conditions?

Too much debris means poor seed germination.

Guidelines

Specific answers to these questions are complex, but there are some general rules of thumb that can be followed, and obeying these rules should result in not going too far wrong! Although the relationships between soil organic materials, seedbeds, and rooting subsoils are complex and apparently change under differing site conditions, there are common threads. Decayed wood and other organic materials are almost always found as a rooting medium for conifers of all ages, in virtually every site condition where the material is available. Where conditions combine to create a drought problem, the organic material-rooting relationship is particularly strong. Droughty sites are usually less productive and therefore most likely to have soils impoverished in organic reserves.



"So," Harvey says, "when preparing a site for regeneration, destroy no more of the organic microsites than necessary to produce an adequate mineral base for seed germination. Take particular care with dry sites. Always leave at least 10 to 15 tons per acre of debris on those sites." He adds that managers

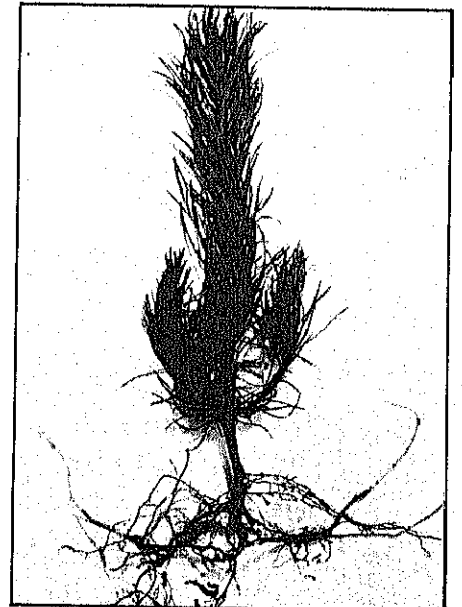
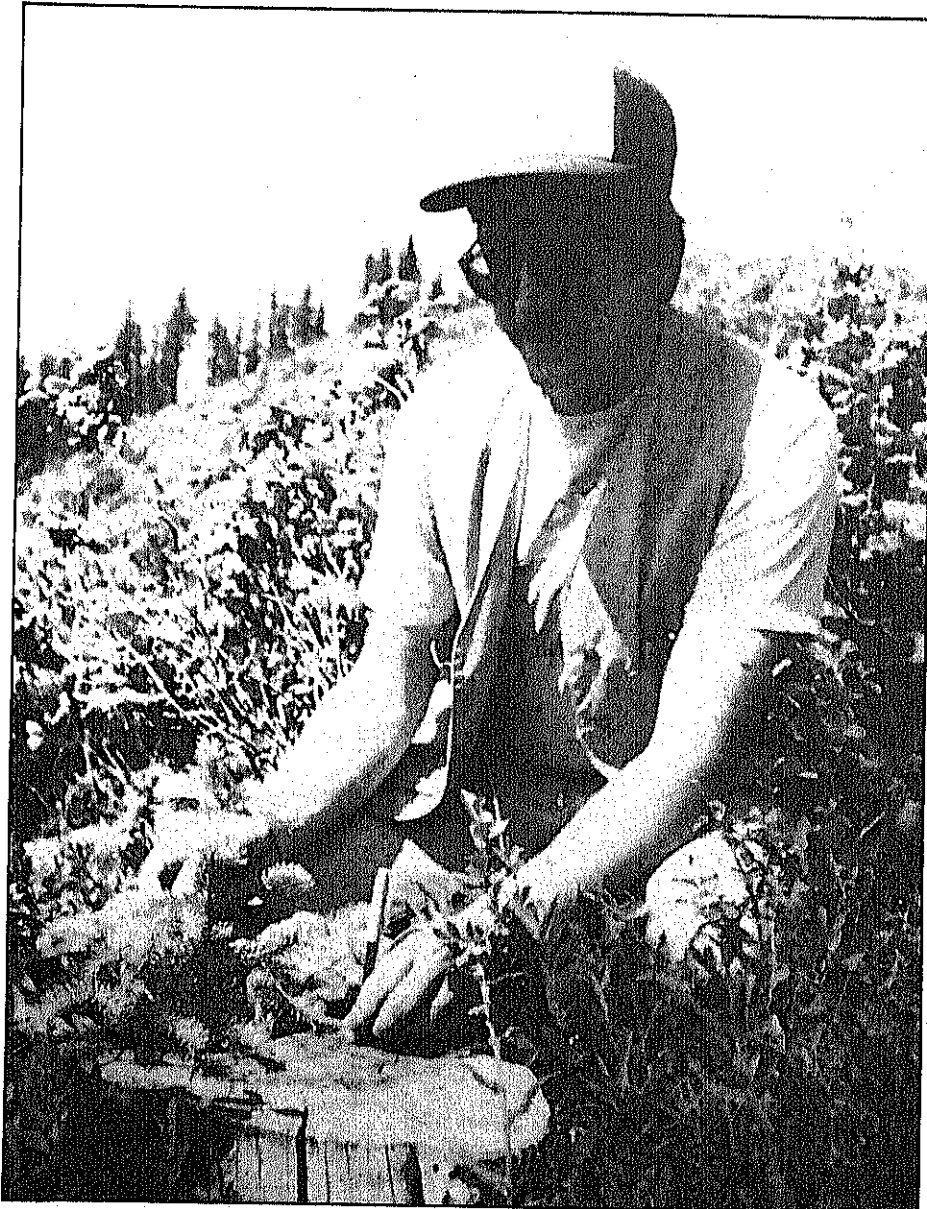
Researcher measures seedling growing in "nurse log."

should strive to create a mosaic of maximum possible diversity. Thus, the precise balance of organic materials to mineral base required for the desired site-species mix will be on at least a small percentage of the land base. When planting, he recommends placing seedlings near a source of organic material (decayed wood, if possible). Natural seedlings frequently occur in straight lines,

usually associated with brown-rotted logs or other deposits of organic matter buried in the soil. The occurrence of the "nurse log" phenomenon with West Coast species is well known, but it is not limited to the West Coast. It also occurs under established stands of Douglas-fir, subalpine fir, and western red cedar in the Northern Rockies.

Harvey, Jurgensen, and Larsen have developed information on the microbial activities that lead to seedling mortality or lack of seedling vigor. They have also determined how environmental factors of the site on which seedlings are to be grown contribute to mortality or lack of vigor. Ron Hamilton says that when nursery personnel transplant tree seedlings from the nursery they work hard to make sure that seedlings contain mycorrhizae.

A healthy nursery seedling ready for transplanting.



Nursery workers often comment, "My gosh, look at those little hairy things!" But those "little hairy things" are vital to the success and growth of seedlings.

Fire, as well as decay, plays an interactive role in recycling wood and other organic materials in forest ecosystems. Studies have shown that broadcast burning, or minimal windrowing or piling for later burning, is most compatible with harsh sites. Similarly, lopping and scattering of woody debris will encourage its decay and minimize its potential to cause wildfire. Extremely hot wildfires are disastrous to soil organic reserves.

Once debris or other parent materials are removed, they are not easily replaced. Turnaround times for replacing rotted wood in forest soils of the Northern Rocky Mountains are in the realm of 100 to 300 years, sometimes longer. Nevertheless, debris management is one way to moderate the extremely harsh conditions under which seedlings, natural or planted, must "make their way" in the various environments of the Central and Northern Rocky Mountains.

The latest estimate of the national reforestation backlog (October 1977) was 1.7 million acres, of which 1.2 million acres could be reforested by 1984. In the Northern and Intermountain Regions, the current backlog amounts to nearly 500,000 acres, with 100,000 requiring reforestation each year. Many of these acres are harsh sites that will be difficult to reforest, and although a current acreage estimate is not available, many sites are not harvested because land managers recognize potential reforestation problems.

Researchers Harvey, Larsen, and Jurgensen are continuing to add to the knowledge of soil biology and its effect on productivity. The technology will help land managers meet the challenges of reforestation.

Symposium proceedings

Several facets of Harvey, Larsen, and Jurgensen's research are included in the proceedings of a symposium held in Missoula, Montana, in 1979.

Environmental Consequences of Timber Harvesting in Rocky Mountain Coniferous Forests, General Technical Report INT-90, includes:

"Biological implications of increasing harvesting intensity on the maintenance and productivity of forest soils", by Harvey, Jurgensen, and Larsen.

"Ecology of ectomycorrhizae in northern Rocky Mountain forests", by Harvey, Larsen, and Jurgensen.

"Microbial processes associated with nitrogen cycling in northern Rocky Mountain forest soils", by Jurgensen, Larsen, and Harvey.

"Residue decay processes and associated environmental functions in northern Rocky Mountain forests", by Larsen, Harvey, and Jurgensen.

Some other publications on this subject include:

The importance of residual organic debris in site preparation and amelioration for reforestation, by Alan Harvey, a reprint from the symposium on "Site Preparation and Fuels Management on Steep Terrain," Washington State University, 1982.

Rate of woody residue incorporation into northern Rocky Mountain forest soils, by Harvey, Larsen, and Jurgensen, RP-INT-282, 1981.

Strategies for improving the yield of Douglas-fir

by Samuel T. Frear
Pacific Northwest Station

The idea that the agricultural strategy that produced the "Green Revolution" in crops such as corn, wheat, and rice may be a broadly applicable model for the management of Douglas-fir is questioned by a Pacific Northwest Station scientist.

Geneticist Roy Silen in his publication "Nitrogen, Corn, and Forest Genetics," doubts that this model really fits a long-rotation forest such as Douglas-fir. His analysis looks at the components of the strategy that have contributed a fourfold or fivefold increase in cereal crops. He concludes that the principles are the same. In fact, the strategy works for forest nurseries and Christmas tree farms. But he concludes that Douglas-fir forestry is different enough from agriculture to require a serious appraisal and additional research before the strategy can be used.

The basis of the agricultural strategy is to increase the number of plants

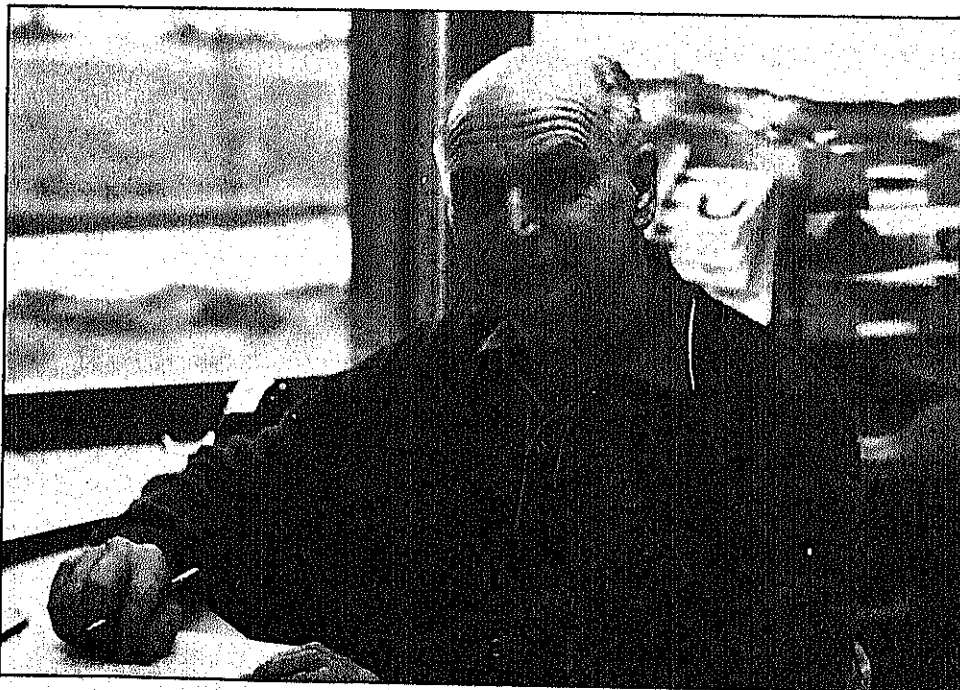
per acre by relieving constraints such as drought, cold, pests, soil infertility, and competition from other plants and by genetically upgrading the uniformity and harvestability of crops. Amplified yield in agriculture needs sustained inputs of moisture, fertilizer, pest control, and energy, plus genetically altered plants.

"This agricultural strategy is a trade-off," Silen observes. "The traditional farmer is asked to exchange the objectives of a reliable, sustained yield at the land's carrying capacity for an objective of increased yield. The price to the farmer, willingly paid, is a future of continuous inputs of energy, fertilize, water, and pest control, plus a restructured problem-prone plant."

Two problems poorly addressed by the agricultural strategy arise with Douglas-fir. One is the impracticality of relieving cold, drought, and pest constraints. The other is that Douglas-fir stands must stay as reliable as they are now, considering the little attention management can afford, Silen observes.

The question for foresters, if they want to use these agronomic techniques, is whether the total price and payoff can be as favorable as it is for farmers. Silen looks at each technique (thinning, fertilizer application, weed control, and genetics) to appraise its long-range effects, problems, and especially its limits regarding yield. He urges foresters to tackle the problem of using the strategy. An holistic view is needed, he says, that goes beyond agricultural strategy to address its weak spots for long rotation, and relatively low-return crops grown on basically poor sites. He proposes such a strategy for Douglas-fir forests. Following are some of the elements he considered:

Geneticist Roy Silen doubts that Douglas-fir forests can benefit from the "Green Revolution" agricultural strategy.



Precise genetic adaption

A major hypothesis is the idea that genetic composition of Douglas-fir stands is a precise, perhaps template-like, adaptation to site. The parallel from agriculture is that land races of corn or rice, grown by the farmer each year from seed of the last crop, have precise adaption to that farm. This precise adaption is expressed in changing genetic expression of each trait.

As tree populations from Douglas-fir seed, gathered at various levels on a mountainside, are tested together, increasingly poorer growth is usually seen for those from upper portions of the slope than those from intermediate or low elevations—an adaptation to shorter growing seasons and increasing cold. Many other traits display clinal variation to drought and other factors as well.

As with agricultural land races, Silen thinks that this precise adaptation is the key to trouble-free sustained good growth over hundreds of years in a tree such as the Douglas-fir. The difficulties of artificially matching this precise adaptation with planted stands would be great. Silen cites examples of serious problems when the match has been poor and suggests that all mismatches will eventually show some problems.

Improvement of yield

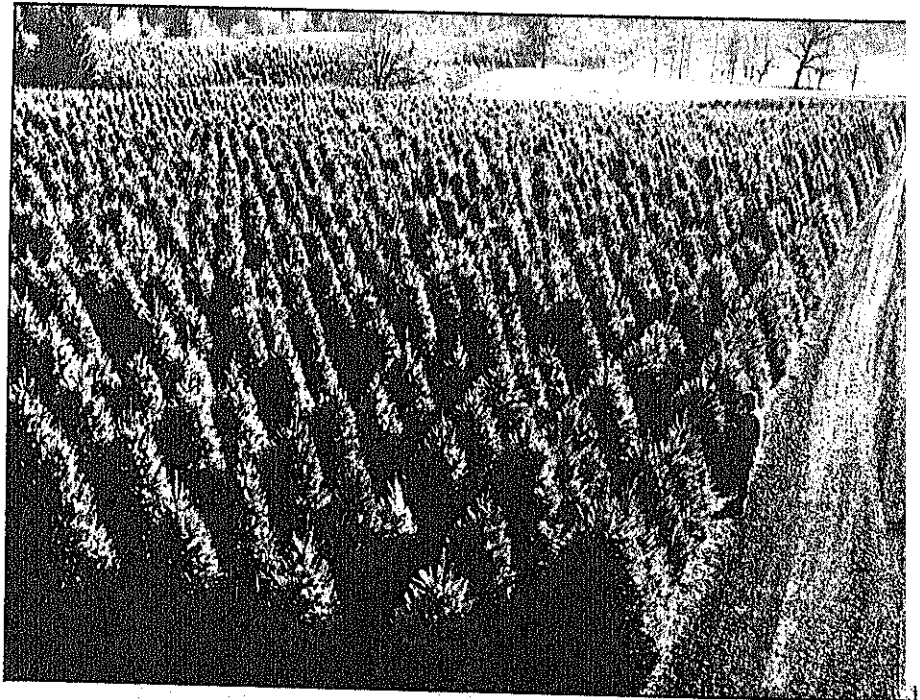
Another major hypothesis accepted in the agricultural strategy, and apparently applicable to Douglas-fir, is the "law of constant, final yield." Developed by Japanese scientists, the law states that final yield per unit area is constant and independent of plant density. Silen's extra-

potation for foresters is that unless they alter the site favorably year after year, they cannot expect increased productivity.

Increased yield of Douglas-fir can be accomplished mainly by exceeding the original carrying capacity of the land by providing nutrients, moisture, and energy. And, as in agriculture, the altered site conditions probably require a genetically different type of tree population to use the site efficiently. The problem is that everything else about the altered site changes as well—the

weeds, the insects, the diseases, and the soil organisms. All these need to be handled with some genetic precision in the new population as part of the change.

Silen is convinced that not enough emphasis has been given to the value of reliability that now characterize native stands, especially considering that Douglas-fir lives for many generations. This may be the first quality sacrificed for improved agricultural yields, but Silen says it should be the last thing given up for Douglas-fir management.



The "Green Revolution" agricultural strategy works for Douglas-fir only in forest nurseries and Christmas tree farms.

Maintaining soil nutrients

Increasing soil fertility is one of the main options the forester has for increasing yield. Silen's analysis suggests no farmlike parallel for using fertilizer in Douglas-fir management. Four constraints must be considered in its use.

The first is environmental: drought and cold override the effects of fertilizer much more severely in forestry than in agriculture. The second potential constraint is that increases in yield may be possible

in a rotation when the stand is understocked. Overstocked stands seldom show much net growth from fertilizer. The third restraint involves the complexities of nutrient cycling and nutrient reserve. It may be difficult to improve the nutrient status of native stands. Silen observes that most foresters do not realize the size of the nitrogen reserve that accumulates over the centuries in a stand. It is, he says, like a perpetual

Most foresters probably do not realize the size of the nitrogen reserve that accumulates over the centuries in a stand.

fertilizer factory, and it annually releases far more nitrogen over a rotation than foresters would willingly apply as fertilizer.

The final constraint is that changes in site productivity will probably go hand-in-hand with genetic changes in the population; that is, if better fertilization leads to increased yields of Douglas-fir, a genetic adjustment of the forest is probably necessary. The best evidence is that Douglas-fir populations have been shown to have inherently different growth rates on good or poor sites over short distances.

For the farmer with an annual crop, these four constraints can be largely ignored. A forest stand, however, would show measurable effects over time, reflecting improved or declining fertility, understocked and overstocked periods, declining nutrient reserves, and maladaptation.

Genetic restructuring of plants

Many foresters look on genetics as a way to independently increase the yield of Douglas-fir. In agriculture, genetics supports measures that improve the site by preventing the faster growing plants from lodging (being beaten down by rain) or by using less space per plant to permit more plants per acre. Silen is not sure whether genetic gains will be substantial without site enhancement even though much research suggests appreciable independent gain from forest genetics.



One problem with genetic research to date is lack of studies on improved yield per acre in contrast to yield per tree, and lack of long-term studies on adaptation.

Because, as in many plants, there is an inverse relationship between growth and hardiness of Douglas-fir, trees genetically improved for faster growth than normal for a site may carry a greater long-term risk of loss. Thus, the documented instances of improved growth can be viewed either as some genetic gain or as rapid growth over a shorter term of genetically vulnerable, inadequately adapted plants.

Having said all this, however, Silen is optimistic that genetic improvements can be made. "Our wild trees are so unimproved compared with agricultural land races with centuries of domestication, that modest gains may be possible before site constraints are even taxed," Silen said. The emphasis could be placed, for example, on better inherent growth to capture underutilized space or to overcome competition from brush, to improve uniformity and quality. Other potential goals for genetics are to find ways to make trees resistant to pests or to restructure the tree to fit the altered environment.

Where do we go from here?

Silen makes several observations about increasing yield from the forest:

The first is that there is no greater opportunity for increasing yields of Douglas-fir than the traditional forestry role of bringing understocked and nonstocked lands to full stocking. Nearly one-third of cutover lands in the Pacific Northwest are understocked.

The second observation is that there really is no free lunch. If the yield of Douglas-fir is to be increased, there are inevitable costs associated with it. Simply put, young Douglas-fir plantations must be artificially and constantly maintained—somehow—at a higher site quality than each plantation's present capacity. The ecological constraints would have to be removed by bringing in water, nutrients, and energy. If this is accomplished, inevitable genocological changes in the tree and its associated plants and pests will occur.

A third observation is that "yo yo" management may be worse than no management. A high yield technology one decade cannot be forgone the next decade if a Douglas-fir population is genetically altered to take full advantage of site enhancement; without intensive management during the forgone period it may well do worse than the native population.

Silen has five requirements or observations for maximizing yield:

- (1) The soil must be improved, not degraded, for maximum crop production over a long timespan.
- (2) The land must be completely occupied all the time by a full canopy of growing plants.
- (3) The crop, in turn, must be genetically capable of using the site completely.
- (4) Maximum potentials are seldom attained because final yields are mainly set either by natural environmental constraints on growth or by those constraints partially relieved by humans.
- (5) Continuous genetic variation is used by plants to fit populations

precisely to climatically varying environments, with template-like precision. Such precision maximizes crop reliability.

Silen proposes a tentative yield strategy for Douglas-fir which would stress maintaining a stable, trouble-free ecosystem at low cost. This strategy would first assess how much site enhancement over the land's carrying capacity it is practical to maintain indefinitely. Then, beginning with the adapted local population, genetic alteration would be limited to producing a new population with an appropriately faster growth rate that is as adaptable and stable as the original one.

Silen concludes that experience to date tells foresters that much more silvicultural information is needed before they make irretrievable commitments to increase yields. He also suggests that "our native tree population, which we seem to thoughtlessly waste, may be our prime resource when the world of the 21st century must once again return toward truly sustainable yields."

For further information:

Copies of *Nitrogen, Corn, and Forest Genetics—the Agricultural Yield Strategy—Implications for Douglas-fir Management*, General Technical Report PNW-137, by Roy R. Silen, are no longer available from the Pacific Northwest Station. Copies may be obtained from the National Technical Information Service, 5385 Port Royal Road, Springfield, Virginia 22161.

New slide-tape series on silviculture

by Rick Fletcher
Rocky Mountain Station

Forest managers need a great deal of silvicultural knowledge and information readily available to aid them in writing prescriptions (formulas for managing timber) and evaluating stands and treatments.

Scientists at the Rocky Mountain Station have developed a series of slide-tape programs to help resource specialists understand and apply the most appropriate silvicultural systems for the major Central Rockies timber types.

Each slide-tape program emphasizes the importance of keeping accurate inventory information.



Currently three programs are completed and available for use:

- 1) Overview of Silvicultural Systems in the Central Rocky Mountains
- 2) Silviculture of Lodgepole Pine in the Central Rocky Mountains
- 3) Silviculture of Spruce-fir Forests in the Central Rocky Mountains

Two other programs are in the making:

- 1) Silviculture of Ponderosa Pine in the Central and Southern Rockies (should be available sometime this summer)
- 2) Silviculture of Aspen in the Central Rockies (should be available by this fall)

Authored by Station Silviculturists Wayne D. Shepperd and Robert R. Alexander, each slide-tape is accompanied by a brochure that duplicates the script and slides. The brochures are intended to help the resource specialist recall the details of concepts discussed in the presentations. They also offer additional references to research publications on the covered topics.

Overview

The Overview program provides a general background concerning the factors to be considered when applying silvicultural practices in the Rocky Mountain Region. It discusses the silvics of spruce-fir, lodgepole pine, and ponderosa pine; and such regeneration methods as even-aged cutting, clearcutting, standard and simulated shelter-wood, and seed-tree cutting.

The "regeneration triangle" is also detailed, explaining the importance of three critical elements needed for regeneration—an ample seed source, a suitable seedbed, and compatible environmental conditions.

Other important points covered in the Overview include slash disposal, seedbed preparation, and protection of residual trees during felling and skidding.

Lodgepole pine

Lodgepole pine grows throughout the Central Rockies. In fact, it is the second largest timber resource in this Region. Site and stand diversity, combined with the relative intolerance of the species, variation in cone serotiny, and susceptibility to dwarf mistletoe and insect attack, complicate the silviculture and management of this species.

This program will help silviculturists and forest managers understand the interrelationship of these factors, and choose the proper management for a given stand. It discusses various stand conditions, damaging agents (such as wind, insects, diseases, birds and mammals), re-

generation factors, different cutting methods, and cutting restrictions.

Spruce-fir

Englemann spruce and subalpine fir occupy the highest forested areas in the Central Rockies. The diverse climate and habitat types make the



Seedbed preparation is just one of the many silvicultural topics covered in the new programs.

practice of silviculture within these forests a unique and sometimes complicated art.

The spruce-fir program outlines common stand conditions; factors affecting initial establishment of seedlings; and damaging agents

such as insects, birds and mammals, diseases, and wind. Also covered are management with advanced regeneration, and reproduction after cutting—detailing the management options available under various stand and windrisk conditions.



The programs suggest, as a general rule, that naturally occurring groups of trees be either cut or left.

To order

Copies of these slide-tape programs and the accompanying booklets have been distributed to all National Forests in the Central Rockies that manage these forest types.

Orders for single copies of the brochures are available on a first come basis from the Rocky Mountain Station. Information concerning the loan or purchase of these programs, or on bulk orders of the brochures can be obtained by writing:

Public Affairs Officer
USDA Forest Service
Rocky Mountain Forest and
Range Experiment Station
240 West Prospect
Fort Collins, Colorado 80526
(303) 221-4390, ext. 283
FTS - 323-1283

These presentations can be shown on most cassette tape recorders with capabilities of reading slide change cues (at 1 KHz), and transmitting those cues to an attached slide projector.

New publications

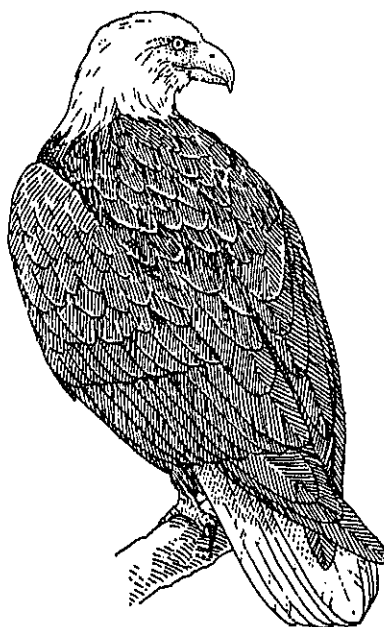
Improving stream habitat of anadromous fish

Two additional publications in the series on anadromous fish habitat in Western North America have been published by the Pacific Northwest Station. The series is intended to provide managers with the most complete information available to estimate the effect of different management strategies.

Rehabilitating and Enhancing Stream Habitat: 1. Review and Evaluation, General Technical Report PNW-135, by James D. Hall and Calvin O. Baker, reviews past techniques—both successful and unsuccessful—for improving spawning and rearing habitat. They provide field managers with some practical information about efforts to rehabilitate or enhance fish habitat.

Rehabilitating and Enhancing Stream Habitat: 2. Field Applications, General Technical Report PNW-140, by Gordon H. Reeves and Terry D. Roelofs, approaches the subject in a different way. These authors concentrate on successful projects with the objective of establishing a point of departure for future efforts. They describe methods used for improving spawning, rearing, riparian habitat, and access to streams for fish.

Copies for these two publications are available from the Pacific Northwest Station. Other publications in this series were listed in the January, 1983 Issue of *Forestry Research West*.



Identifying bald eagles through voice prints

Preliminary results of research at the Pacific Southwest Station indicates that voiceprinting the calls of forest birds may be a reliable way to distinguish one individual from another.

A recent publication, *Identifying Individual Bald Eagles with Voiceprints: a feasibility study*, Research Note PSW-359, suggests the possibility that vocal distinctiveness among songs of bald eagles might be used to investigate aspects of the eagle's life history, including seasonal use of nest sites, long-term survival, and the source of birds aggregating in winter roosts.

Voiceprints are made by recording calls of each bird with a high-fidelity tape recorder. The tapes are fed into an audiospectrograph, which produces a printout known as a voiceprint or sonagram.

A major advantage of the technique would be elimination of the need to capture, handle, and mark the birds.

Copies of Research Note PSW-359 are available from the Pacific Southwest Station.

Shelterbelts for snow control?

Scientifically designed snow fence systems have provided effective highway snow control for a number of years in locations where blowing snow is a problem. While the value of these systems is well proven, questions have arisen over whether shelterbelts might also serve the same snow control function.

Scientists at the Rocky Mountain Station recently conducted a study along Interstate-80 in southern Wyoming (with some of the most severe blowing snow conditions in the country) to determine the ability of several tree and shrub species to establish and grow in this type of environment.

A report about this research discusses species used in the shelterbelt planting (Colorado blue spruce, ponderosa pine, white fir, Russian olive, Siberian elm, Siberian peashrub, basin big sagebrush, oldman wormwood, and white rabbitbrush) and their survival and growth characteristics during the first 5 years after planting.

While results showed that several were adaptable to this area, they will not become large enough to be effective snow control agents for a number of years after planting. The report explains that depredation by small mammals severely limited establishment and growth of several species, even more than the harsh climate.

For more details on this research, write the Rocky Mountain Station and request, *Shelterbelt Establishment and Growth at a Windswept Wyoming Rangeland Site*, Research Paper RM-243, by David L. Sturges.

Decreasing damage to residual trees after logging

Logging damage in commercially-thinned true fir stands in Northern California can be significant, Pacific Northwest Station researchers have found. They recommend new harvest sale procedures and improved sale administration to reduce the damage.

In studies conducted on the Lassen National Forest, the scientists found that a very high proportion of trees left after logging were damaged, and infection of the wounds by decay fungi caused serious volume losses. Decay losses associated with wounds were 6.8 and 14 percent of gross merchantable volume in the study areas.

The injuries that cause decay to residual trees can be substantially

reduced by use of specific procedures for harvest preparation, including reduction of size and type of logging equipment, marketing of residual trees, laying out skid roads, using straight-line skid patterns, leaving buffer trees, and limiting log length.

Other procedures to reduce damage are sale administration practices, including improved communication with operators, felling procedures, use of directional falling, preparing trees for skidding, and treating stumps against infection.

Copies of *Logging Damage in Thinned, Young Growth True Fir Stands in California and Recommendations for Prevention*, Research Paper PNW-304, by Paul E. Aho, Gary Fiddler, and Mike Srago are available from the Pacific Northwest Station.

MPB study results

Mountain pine beetles—destructive forest pests. Between 1965 and 1978 these insects killed many thousands of ponderosa pines throughout Colorado's Front Range (eastern foothills). Scientists at the Rocky Mountain Station conducted surveys during the outbreak to learn "what happens to a ponderosa pine forest during an uncontrolled mountain pine beetle outbreak." Results of this study have now been published in a report that provides specific data on the amount of beetle-caused tree and stand mortality.

Findings indicate that the insects in outbreak numbers do not kill whole forests—many individual trees, as well as relatively intact patches and stands, do survive. In this case, 75% of the trees survived and 38% of the original basal area remained after the outbreak ended. Trees infected with dwarf-mistletoe are more susceptible to beetle attacks than are healthy ones.

Scientists suggest a program of stand thinning, combined with use of protective sprays of carbaryl, to limit tree losses.

To learn more about this study and the management implications, write the Rocky Mountain Station and request *Ponderosa Pine Mortality Resulting from a Mountain Pine Beetle Outbreak*, Research Paper RM-235, by William F. McCambridge, Frank G. Hawksworth, Carleton B. Edminster, and John G. Laut.

Classifying mountain meadow sites

Meadows of the Sierra Nevada are fragile yet the most biologically active of this region's plant communities. They are important for the production of forage on forest grazing allotments. They provide wildlife habitat, and their timbered edges are favored campsites for forest visitors. The meadows also help to filter sediment from water of surrounding slopes, thereby assuring clean streams and lakes.

Because of these multipurposes, land managers face special challenges in the maintenance, restoration and management of meadows.

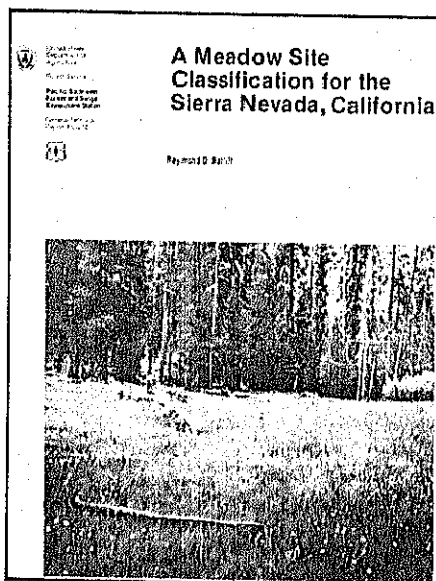
Guidelines are needed to assist managers in decisions on cultural treatments—reseeding, weed control, gully stabilization, and grazing schedules. But the guidelines should be developed for the varying kinds of meadow sites, rather than for meadows in general. Before such guidelines can be developed, better classification systems must be established.

Raymond D. Ratliff, a range scientist at the Pacific Southwest Station, has now proposed a classification system for mountain meadow sites. The system is described in General Technical Report PSW-60, *A Meadow Site Classification for the Sierra Nevada, California*.

During a 5-year-period, Ratliff sampled 90 differing meadow sites in the Stanislaus, Sierra, and Sequoia National Forests, and in the Yosemite and Sequoia-Kings Canyon National Parks. He used 72 sites to develop the classifications, and the other 18 sites to evaluate the application of the classifications.

The report describes 14 meadow site classes that were derived through techniques of cluster analysis. A stepwise discriminant analysis is used to derive classification functions for quantitatively classifying new sites, and a key to the classes is provided in the report.

Copies of General Technical Report PSW-60 are available from the Pacific Southwest Station.



This threat is related to the greater human presence and the accumulating masses of untreated logging slash, which can dry quickly during recurring periods of warm, dry weather.

Fire managers in Alaska concentrate on those areas where the wild-fire potential is greatest. Though fire danger is monitored, less planning effort is expended with increasing wetness of climate.

Responding to requests for a further refinement of coastal Alaska fire-danger climatology, Arnold Finklin, meteorologist at the Intermountain Station, has developed a method of defining fire-climate classes. The system consists of an index of fire danger and simple climatic averages in a multiple regression. The fire-climate classes are then applied to depict fire-climate zones. The report, *Fire-Climate Zones of Coastal Alaska*, General Technical Report INT-128-FR33, should be a valuable tool for fire managers in the Alaska Region. Copies are available from the Intermountain Station.

Weather and fire in coastal Alaska

The coastal Alaska area does not often experience major wildfires. The maritime influence on the climate is an obvious tempering factor with respect to fuel moisture. There is, also, a near absence of lightning as an ignition source. Severe burning conditions, nevertheless, do occur in some years, even in normally wet areas. Recreational and logging activities are increasing, threatening a more serious fire problem in the future.

Procedures for planning fish and wildlife projects

A system to improve fish and wildlife programs and projects on national forests has been developed by Pacific Northwest Station researchers.

The researchers have developed a system to evaluate fish and wildlife projects to assist forest biologists who cannot obtain all the proper information for each alternative project and have, therefore, had to rely on short-cut procedures and rules of thumb. Procedures for planning programs and projects are explained and illustrated in the publication *Evaluating Projects for Improving Fish and Wildlife Habitats in National Forests*, General Technical Report PNW-146, by Fred H. Everest and Daniel Talhelm.

There are three phases of the system: (1) Program planning includes identifying needs, selecting projects to meet the needs, selecting geographic areas for projects,

selecting proper sites, and evaluation of potential projects. (2) Project planning is a system to make an intensive analysis of benefits and costs. (3) The final element is project evaluation: the assessment of the accuracy of the benefits and costs estimates.

The authors believe the system will assist forest managers to select projects which provide the greatest benefits.

Copies of PNW-146 may be obtained from the Pacific Northwest Station.

Measuring tree mortality from photographs

In the Forest Service's Northern Region, current management planning inventory methods rely on ground point sampling methods. These methods provide efficient estimates of stand development using variables such as volume, diameter, and height of trees in the plot. But they don't provide an efficient method for collecting information on tree mortality rates.

In 1981, David A. Hamilton, Jr., research forester at the Intermountain Station, developed a relatively inexpensive method to estimate mortality rates. The system consists of using large-scale color transparencies (70 mm format) obtained by aerial photography.

The Intermountain Station has issued a report, *How to Interpret Tree Mortality on Large-Scale Color Aerial Photographs*, that describes photointerpretation techniques for use in sampling for mortality rates in the Inland Empire. Authors are Frank C. Croft, an analyst with International Imaging Systems, Incorporated, Milpitas, California; Robert C. Heller, formerly professor of remote sensing at the College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, now retired; and Hamilton, who is stationed at the Forestry Sciences Laboratory, Moscow.

Copies of General Technical Report INT-124-FR33, are available from the Intermountain Station.

A pictorial record of forest succession

Over 70 years ago, in 1909, when the first large timber sale (2,135 acres) was under way in the Northern Region, a Forest Service photographer was sent west from Washington, D.C. to document the logging activity. Today those photographs are the basis for a pictorial record of 70 years of vegetative change on the Bitterroot National Forest.

Seventy Years of Vegetative Change in a Managed Ponderosa Pine Forest in Western Montana—Implications for Resource Management, General Technical Report INT-130-FR33, contains 74 photographs that provide an unusual opportunity to interpret changes. Authors are George E. Gruell, research wildlife biologist at the Intermountain Station's Northern Forest Fire Laboratory, Missoula; Wyman C. Schmidt, research silviculturist and project leader at the Station's Forestry Sciences Laboratory, Bozeman; and William J. Reich, a former Station employee.

In the report, the authors discuss the reasons for the vegetative changes pictured and the implications for wildlife, timber, fuels, esthetics, and livestock grazing. Their observations can help provide a basis for management decisions in the ponderosa pine/Douglas-fir forests of the Northern Rockies.

Copies of the report are available from the Intermountain Station.

Estimating fuel moisture

A new Rocky Mountain Station report titled *Estimating Ponderosa Pine Fuel Moisture Using National Fire-Danger Rating Moisture Values*, discusses comparisons made between moisture contents of natural ponderosa pine fuels and the corresponding timelag moisture values calculated using the National Fire-Danger Rating System.

These comparisons were used to evaluate the accuracy of the fuel moisture models in estimating actual fuels moisture, and to develop equations to provide better estimates of fuel moisture for use in prescribed fire planning.

Agreement was found between the moisture content of natural fuels and the corresponding NFDRS time-lag fuel moisture content. A one-to-one relationship between actual and calculated moisture contents was not found where precipitation was influential. However, at the lowest moisture levels when there had been no precipitation for 24 hours, the one-to-one relationship was approached. Even though the NFDRS moisture estimates were not exact over the entire moisture range for this study, estimates were quite accurate under the drier conditions. This is where precise information concerning potential wildfire behavior is deemed critical.

For your copy of the report, write the Rocky Mountain Station and request Research Paper RM-233, by Michael G. Harrington.

To order any of the publications listed in this issue of *Forestry Research West*, use the order cards below. All cards require postage. Please remember to use your Zip Code on the return address.

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 - ☐ *Logging Damage in Thinned, Young Growth True Fir Stands in California, and Recommendations for Prevention*, RP-PNW-304.
 - ☐ *Evaluating Projects for Improving Fish and Wildlife Habitats in National Forests*, GTR-PNW-146.
 - ☐ *Indicators of Cull in Western Oregon Conifers*, GTR-PNW-144.
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 - ☐ *Fire-Climate Zones of Coastal Alaska*, GTR-INT-128-FR33.
 - ☐ *Handbook for Inventorying Surface Fuels and Biomass in the Interior West*, GTR-INT-129-FR33.
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